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Study at : **Biodeterioration of external painted walls**
Cause sand control

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ABSTRACT:

In the exterior walls of buildings in major cities in developing countries they are covered with gypsum bricks on

which paint is applied to provide an aesthetic function. However, this job may be of short duration due to the constant threat of exterior wall paint finishes caused by environmental factors. In particular, these factors reduce the durability of the coating finish on external wall surfaces. This is more evident in warm and humid environments due to the combination of different climatic conditions.

This is more problematic when the temperature reaches high levels. Again, moisture also causes problems with paint finishes because it slows down the evaporation of water-based paints especially when the paint is applied to exterior building walls.

Even when solvent-based coatings are applied during high humidity, moisture can still cause cracks or bubbles as the coating dries. This, in particular, can lead to drips and dirt due to dust contamination. Thus, in this regard, research to evaluate and suggest ways to reduce environmental variables related to the service life of exterior wall paint is necessary and required. Most importantly, a study of this kind with a special focus on cities and peri-urban areas in developing countries deserves academic attention.

CHAPTER ONE :

1.1 INTRODUCTION

Paint can be defined as “a liquid substance that when spread over a surface in a thin layer, will form a solid, cohesive substance. The term paint describes a variety of materials including enamels, undercoats, and varnishes. Paints and other surface coatings give two major properties to structure, protection, and decoration. Recently Other functions have been developed, such as new "paints", which improve the building's insulation. All of these characteristics may be biased by microbial growth. Bacterial reproduction on exterior paint causes buildings to have aesthetic problems and can lead to deterioration and blistering of concrete walls, peeling Paint too.

The financial losses resulting from the biological growth of roofs are calculated annually, since as long ago as 1981 caused economic losses in excess of US$1 million annually and modern buildings, with increasing levels of thermal insulation, exhibit higher risks of microbial growth.

Many architectural structures and other buildings undergo biological growth when exposed to contact with soil, water, and sewage.

Biodegradation refers to unwanted changes in a substance, which are caused by living organisms. Living organisms form specific communities that interact in many different ways with the concrete and its external environment. This complex phenomenon occurs in conjunction with many destructive physical and chemical processes. Thus, it is difficult to distinguish the extent of damage caused by biotic factors from that caused by abiotic factors: (they combine non-living chemical components and natural things in the environment that have an impact on living organisms and the ecosystem. These factors, along with other phenomena, affect concrete walls and concrete)

Microorganisms are deposited on painted surfaces from the surrounding environment. On external surfaces, rain and wind bring small fragments of plant and animal origin, spores and microbial cells, as well as metals and air pollutants. Internally, atmospheric microorganisms are derived from external air, but

Information related to external surfaces. Once they hit the surface, microorganisms adhere and grow at rates that depend on the nature of the coating, the coating's substrate and environmental conditions. Thermal conditions are of particular importance, high humidity or condensation, along with high temperatures, conducive to growth. The components of the coating also affect the microbial development, some components being inhibitory and other factors stimulating growth. Substances such as cellulose derivatives can act as nutrients for cells,

1.2 The Study Problem:

The growth of microbes on the facades causes an aesthetic problem. Microorganisms among other active things participate in the weathering and deterioration of facades and paints. In order to save more energy, more buildings have thermal insulation. This makes the system particularly vulnerable to biological attack, necessitating its use of biocides.

Since environmentally toxic biocides with a broad scope of protection are prohibited by law (Biocidal Products Directive 98/8/EC), the paint industry is forced to use non-environmentally toxic and non-biodegradable materials, for example organic-based biocides. So work is being done in the paint industry to use nanoparticles to increase coating properties and create new coating formulations that meet Biocidal Products Directive 98/8/EC.

Paints that contain biodegradable biocides may lose their protective effect because the biocides can be washed off or inactivated by physical/chemical sources. So the paint industry

Working on different strategies to overcome this problem. Biodegradation-based organic biocides are being replaced by nanomaterials and it is one of the different strategies, which the paint industry has taken into consideration. For example, materials in the form of silver nanoparticles, such as nano-silica dioxide, are used to improve coating properties, such as water resistance, scratch resistance, and antimicrobial properties.

1.3 The Importance of Studying :

- Identifying bacteria, fungi and environmental factors such as wind and others that cause the deterioration of the pigments and the fall of the pigment from the painted surface.

- Finding the most effective method at low costs to reduce the deterioration phenomenon of pigments.

1.4 Biodestruction of concrete:

Biological degradation can be defined as unwanted changes to a product, substance or substance, affected by organisms. Organisms are able to interact with nutrients and the physical environment to form specific communities. This reaction and association can lead to many destructive physical and chemical processes. Both vital and non-vital activities contribute simultaneously during the degradation of building materials. Hence, the level of biological growth is difficult to determine due to the involvement of uncontrollable (non-biotic) external factors (such as wind). However, the involvement of

microorganisms in the biodegradation of substances in the environment is estimated at 30% in the United States.

Buildings, like any other material, are subject to bacterial growth, degradation, degradation, or architectural “weather.”

Structures, including buildings and bridges in contact with water, soil, waste, sewage, plant materials or any organic matter, can be damaged. The solid and static nature of these structures only limits the biodegradation process to a slow, inevitable and inevitable erosion process after microbial growth, under favorable conditions.

The presence of usable substrates as part of building components makes some buildings more susceptible to bacterial damage. For example, dyes, diluents, bond, and dryness of the main components of paints used.

The biodegradability of various metal building materials including external concrete surfaces is mostly due to the increased concentration of carbonates and inorganic sulfur compounds, as well as other aggressive chemical reagents of an abiotic or biological nature. Their interactions with metal material components play an essential role in corrosion induction and treatment. It should be borne in mind that the concrete surface is a heterogeneous substance usually consisting of Portland cement, aggregates (coarse and soft), water and additives (optional). Concrete consists of two main concrete stages: aggregate (59-75% of the volume of concrete) and hardened cement paste (25-40% of the volume of concrete) indicating completely different physicochemical properties. However, many physical, chemical and biological factors may affect the destruction of both concrete paste and aggregate. Physical factors may be of internal or external origin. Such concrete damage is mostly associated with poor concrete mixture installation and improper maintenance of concrete. Both frosts and high temperatures are among many of the most often influencing the degradation of the concrete surface as well.

The evaporation of water from the cement paste leads to the formation of pores that allow the entry of water and aggressive reagents, such as Cl-, NO3-, SO42- and CO32-. Besides, some microorganisms grown on the concrete surface and in its pores secrete extracellular polymeric materials that alter the porosity and permeability of the surface. When porous concrete comes into contact with water or saturated earth, the water phase is continuous on the surface of the material and various ions can easily enter the concrete matrix. Many chemicals including acids, alkalis, gases, oils, fats, sugars and many other substances are considered severe corrosive agents that cause chemical corrosion of concrete.

1.5 Resident microbes

(Resident microbes) consist of microorganisms that live under different layers of paint, and can also be found on the surface of the skin. And staphylococcus (human) are the predominant type of them,

External coated surfaces support a very variety of microbes; bacteria (including radial fungi and cyanobacteria), algae and small animals (protozoa, rutevera, nematodes) and a wide variety of fungi Some of these are involved in biodegradation For example, nematode algae, radial fun Many of the microorganisms discovered in the paint are air pollutants that do not grow on the surface and are even involved in degradation.

Fungi are generally considered the main bacteria found on painted surfaces. Fungi were found in all deformed coatings or painted areas on 600 home exterior designs in the USA Fungi of the genus Cladosporium have been identified as the main organisms in the biofilms of these areas in the state of São Paulo, Brazil.

Wood coatings in Florida, USA, exposed to Cladosporium buildup

As the main fungal colonizer after 31 months, while Cladosporium spp. The Aureobasidium pullulans was discovered in Florida, New Jersey and Oregon

Until even fungi growing on a painted surface may not necessarily be a solution to a real coating; they may live on surface dirt or use the base substrate. Photonutrient organisms, cyanobacteria and algae can live without resorting to organic nutrients and are found in the majority of external paint membranes.

Upon surface examination, these biofilms appeared as falling black paint (Figure 1). There were a few fungi, distinguishing these “crusts” from those previously described on the stone Surfaces in areas with high air pollutio

CHAPTER TOW

2.1 Environmental impact on biological growth

The climate, whether tropical, temperate or cold, also the environment and its surroundings such as the urban, industrial, coastal or rural environment, all of the above will affect the level of natural biodegradation that occurs in that region.

Interactions are complex and intertwined, industrial emissions and tree cover, for example, affect the penetration of solar energy and at the same time temperature. Location and climate affect microorganisms and the chemical content of air reaching exposed surfaces.

Climate Changes with the season may also be important; biocontamination on rooftops has been shown to be higher in spring and autumn.

Numerous studies on fungal growth have been published on painted samples prone to natural aging in different environments., as locally the climate has had the most significant effect on the exterior coating of the surface, to overcome any effects of pigment volume content (PVC) and the presence of biocides. The performance of biocides-containing wood coatings has been investigated in Florida, USA. The results varied significantly depending on the location and type of dry membrane preservative used.

However, other researchers have discovered that there is no different or minimal impact of climates on mold growth. No significant traces of different climatic variables and location have been found on painted wooden plates in Norway, but this is almost certainly more logical for minor differences in climatic conditions between them and test sites.

Macromatic climate, on-site weather conditions may be less important for microbial growth than the local climate, the variants on painted surfaces. In São Paulo and southern Brazil (Rio Grande), painted panels showed higher innate colonization on the south-facing sides These were considered the result of increased condensation. The faces of the south receive less solar radiation than the north and their surface temperatures may drop below the dew point at night and remain moist for longer periods after wetting. This trend has also been further affected by the wind rains in São Paulo; these conditions contribute to increased deposition and growth of fungi in exposure to the south-facing surfaces in the northern hemisphere to the highest levels of solar radiation, which

are beneficial for the growth of microbes (especially photovoltaic) at European test sites Although there is some evidence It was cooler and drier after the rain. The obvious paradox of the degree of colonization and its relationship to it may be due to a lack of real knowledge of the factors affecting bacterial contamination on painted surfaces. Humidity can play conflicting roles. In areas where temperatures and precipitation are high throughout the year, painted concrete panels have shown no difference in degradation between north-south-facing surfaces. The presence of air pollution is also expected to affect

On paint colonization suggests that large numbers of fungi in biopaint membranes in São Paulo compared to a smaller city on the coast in the same state (Opatuba) could be due to the high level of air pollution by burning fossil fuels in São Paulo.

2.2 Moisture and vegetation effect

Humidity is annoying to many people and may lead to many damage to home furniture, walls and walls, especially in winter, the most important seasons in which moisture appears in the house. Moisture can be treated through moisture-resistant paint that prevents the presence of moisture and gets rid of it permanently, so as not to cause mold and significant damage to the walls.

Differences have been observed between the bacterial growth of painted surfaces in coastal and terrestrial environments,

The presence of vegetation near the building is another factor affecting the degradation of roofs. In the tropics, the presence of trees can also help with microbial growth and survival by providing shade of intense ultraviolet radiation and keeping humid conditions under the canopy.

2.3 New technologies in the paint industry

In the past few decades, due to climate change, I felt needed to develop new technologies to build a more sustainable environment. One of the strategies in the paint industry is to develop innovative raw materials that can give new jobs over traditional materials. One such development is the use of fine particles or nanoparticles to help reduce energy consumption and urban pollution.

2.4 Photoscatalysis layers

Hydroxyl and superoxide roots, formed when photosynthesis of substances such as titanium dioxide acting on ultraviolet light, are highly reactive to both the oxidation of organic matter and the inhibition of germs, bacteria and viruses despite their effect on

algae and to some extent on fungi is more questionable. There have been no investigations into the activity of photocatalytic nanoparticles against cyanobacteria.

Photocatalysis TiO2 has been described and has been employed in protecting a variety of materials, such as glass and tiles, for some years. However, only a few researches describe photostimulation:

TiO2 reaction to protect building materials such as plaster or paints, processes only work in existence Of UV light, therefore usually outdoors, but second generation

Processing works indoors, using visible light and alternative solar radiation is the use of zinc oxide nanoparticles and local fluorescent lamps TiO2 exists in the form of three metal structures but only two forms are commonly used. Rutile is used as a white pigment in paint architecture due to its high refractive index, resulting in high opacity and whiteness. For photosynthetic applications, anatase is used when exposed to ultraviolet radiation it decomposes organic matter such as fats, oils, volatile organic compounds and even microorganisms and its effect lasts a long time. The use of nano (less than 100 nm diameter) or micro anatase particles can decompose polymeric surfaces such as paints, so to prevent this it is necessary to apply an inorganic barrier between the anatase layer and the polymeric layer, separating the surfaces,

Some workers suggested a mixture of 70e75% anatase and 30e25%

Nanojointase is more effective than the size of particle pigments (rutile), but can affect other components of the coating. Calcium carbonate CaCO3, for example, used as a dilator to reduce photoscatalysis inhibition of bacterial residues, while silica has not shown such an effect Nanoparticles in Paints: A New Strategy for Protecting Facades and Surfaces

The coatings industries take into account the use of silver nanoparticles, photocatalyzed active nanooxide or nanooxide silica as additives to protect surfaces from bacterial, physical and chemical damage, such as an alternative to traditional organic

additives. Another fact is that the potential risks of environmental and human health nanoparticles remain controversial. The most sensitive entry port for nanomaterials is the lung so it usually poses a risk to the health of workers and humans in general.

In our study we can show the following:

- Nanosilver (TEM size 25 nm) was much less toxic than similar silver ions

Concentrations were tested with cells representing the digestive system (CaCo-2) and immune cells (Jurkat, T-lymphocytes). A large amount of dead cells can occur after CaCo-2 cells are exposed to 27 µg/ml of nanosilver for 48 hours.

- Titanium nanooxide can absorb ultraviolet radiation and in the presence of hydroxyl water.

- Nanooxide silicate improves the properties of paints by increasing water. When the cells were exposed to 243 µg/ml of nanosilica dioxide (TEM 19nm volume) for up to 48 hours no cell toxic effect could be observed.

Silver nanoparticles embedded in paints act as a repository of silver ions. He understands. However, silver ions are able to penetrate bacteria and once they enter the cell react to and disrupt thiol groups of vital enzymes leading to dysfunction, cellular and then death. The effectiveness of biocides to silver additives is therefore directly related to their potential and the release of silver ions.

In addition, silver ions interact with DNA and can inhibit the respiratory system and enzymes, as well as induce oxidative stress when generating reactive oxygen species (ROS).

Ionic silver is also able to bind to sulfur- and phosphorus-containing molecules found in the cell and antioxidant defenses.

The paint industry uses photoactive nanotitanium dioxide as a biocide. Photodynamically absorbs active nanooxide and ultraviolet

radiation and produces in the presence of hydroxyl roots in the presence of water. These hydroxyl roots are powerful oxidants and can cause oxidative stress and inflammation leads to oxidative attacks of cellular components protecting paint in surfaces from microbial growth.

Silica dioxide nanooxide is widely used in wood preservation (water permeability) and coating applications. Nanosilica dioxide found in paints improves scratch resistance and increases water resistance, protects paint from corrosion and gives products high gloss. Nanooxide silica also does not clump and is therefore very firm in the water phase. When exposed to high silica, silica dioxide nanodust should be avoided. Hazardous paints by dry detonation can lead to high release of silica dioxide and other minerals. Exposure to high concentrations of breathable silica dioxide can lead to silician dystrosis (a permanent scarring of the lungs caused by inhalation of silica dust) and cancer.

2.5 Danger of using silica nanooxide:

Nanooxide silica can additionally cause necrosis of the lungs at high concentration, the most sensitive entry port to nanomaterials is the lung. Pulmonary absorption is the most A possible exposure scenario and therefore extensively studied. However, other devices/systems They may also be affected by nanoparticles. Nanoparticles may be released from the interface and By surface water runoff, accidentally consumed by animals and/or children. So nanoparticles may come into contact with digestive cells and may also affect our immune system.

2.6 Nanoparticles in pigments resistant to biological growth

Antimicrobial coatings use chemicals to impede the growth of pathogens through cell membrane disorder. In general terms, antimicrobial coating is an application of a chemical agent on a surface that can stop the growth of pathogenic microorganisms. Apart from increasing the durability, appearance, corrosion resistance of the surface, etc., these coatings also protect against harmful pathogenic microbes.

As revealed by the European Centre for Disease Prevention and Control, more than 4 million people are infected with healthcare-related infections (HCAI) each year, resulting in 37,000 deaths. Combating HCAIs is a major problem for the healthcare sector worldwide. HCAIs are the sixth leading cause of death in Western countries. In developing countries the situation is worse.

There is an increase in the need to protect surfaces from germs and microbes. This doesn’t just apply to healthcare devices/surfaces. The need is more widespread From surfaces, equipment and walls to textiles and food, everything is susceptible to microbes, which eventually find their way into humans. Surfaces cannot always be cleaned, disinfected, or powerful chemicals can be used to prevent germ growth. In this scenario, antimicrobial paint seems to be the best option. It is a simple process of coating the surface with antimicrobial agents, resulting in a safer and longer lasting solution

A surface that can hinder microbial growth can be obtained in two ways. The first method is physical modification, which includes material modification and surface roughness. The second method involves chemical change. Chemical changes include polymer grafting, highly waterproof surfaces, and the use of nanomaterials

and coatings. These coatings include self-cleaning coatings and coatings with antimicrobial additives. The level of safety, industry standards and specific use of the coated tool are taken into account when choosing the most suitable coating for antimicrobials.

2.7 Materials used in antimicrobial coatings:

• Graphene Materials: Graphene materials consist of antimicrobial materials such as fullerine, graphite, graphene oxides, original graphene sheets, and graphite oxides. These substances can affect the growth of microbes due to their disruption to the bacterial membrane, oxidative stress, and microorganism retention.

• Graphene-like 2D Materials: Here, Raw And Chemically Peeled MoS 2 Sheets Are Used As Graphene-like 2D Materials Due To Their Antibacterial Activities.

• Polycondensed hydrogel: Polydensed hydrogel consists of an antimicrobial hydrogel based on dimethyldicil ammonium ketosan-graph poly (ethylene glycol) methacrylate poly (ethylene glycol) diacrylate. Matter is thought to cause microbial death.

• Silver Nanoparticles: Silver nanoparticles have a bactericidal effect in the range of 1-10 nm and depend on size.

• Polymer brushes: There are three types of polymer brushes used in antimicrobial coatings: functional polymer brushes, brushes with germicidal polymers and non-dirty polymer brushes.

• Dendrimers: Dendrimers are used in antimicrobial coatings due to their ability to traverse the cellular membrane.

• Copper and its alloys: Copper and its alloys such as bronze, copper, copper, nickel, zinc and coperonicle are known to be

natural antimicrobial elements. These elements can inhibit and destroy the growth of pathogenic microorganisms.

2.8 Antimicrobial coating testing mechanism:

There is no specific test mentioned by the antimicrobial sector as a single test to prove the effectiveness of antimicrobial paint. However, many testing methods have been developed by different organizations to meet industry standards. Some of these tests were drafted by the American Society for Testing and Materials (ASTM), the American Association of Textile and Colored Chemists (AATCC), Japan Industrial Standards (JIS), and the International Organization for Standardization (ISO). Tests help measure the performance of an antimicrobial coating in combating microbial growth and survival.

These tests are designed for specific areas of use, substance, or antimicrobial technique. As a result, it is difficult to choose one method. However, one example of the standard is ISO 22196 (JIS Z 2001) for antibacterial coatings by manufacturers. Antifungal testing methods are ASTM G21 or AATCC Method 30, Part III. Similarly, ASTM E2149 is used to detect antimicrobial activity after one hour of exposure, and ASTM E2180 is used to detect antimicrobial activity 24 hours after exposure on textiles. Also, ASTM G21 is used to determine resistance against black mold and fungus.

2.9 Use of antimicrobial coatings:

Antimicrobial surface coatings are used in many consumer and industrial applications, apart from the healthcare sector, such as:

- Industrial
- Commercial
- Construction products
- Outdoors
- Household items

A prerequisite for antimicrobial coating in the medical field. All healthcare facilities face the risk of HCAIs. Antimicrobial coatings help reduce the spread of germs through common areas such as switches, door handles, etc., moreover, coatings are used on catheters, surgical devices, medical electronics, medical instruments, trays, etc., to reduce the risk of infection during treatment. Procedures. They are now even used in hospital fabrics, including gloves, surgical masks, wound dressings, dressings, woven hospital textiles and non-woven hospital textiles. Innovation in this area has led to the use of these coatings in medical implants as well.

Antimicrobial coatings are useful for a variety of buildings such as schools, office buildings, restaurants, public places and apartment buildings for long-term protection from pathogenic microbes. They are also heavily used in maintaining indoor air quality in air handling systems, such as ventilation, heating, air conditioning, ceilings and fans. Coatings are effective in combating mold growth and regrowth on various surfaces such as automotive components, walls, roof pipes, etc.

Antimicrobial coatings have made their way into the food sector as well, finding their use in food processing units, dairy products, and large-scale production, as well as in pots and containers used in the process. In the textile sector, they help provide durability, freshness and stain resistance to fabrics.

CHAPTER THREE

3.1 The positive side of antimicrobial coatings:

As mentioned earlier, there is widespread growth in the use of antimicrobial coatings not only for the industrial and healthcare sectors where they are most needed, but also for home use. Here are some of the benefits of these coatings.

1. Protection against microbes

First of all, these surface coatings protect against the growth of various microbes such as bacteria, fungi, algae, mold, etc. Research has shown that applying these coatings to surfaces inhibits the growth of various microorganisms. The surface becomes an unfavorable environment for microbes to grow and survive as long as the paint is applied to it. It also prevents stains, odor, or deterioration of the applied surface.

2- Less disinfectants or sterilizers are required

The use of antimicrobial coatings on surfaces reduces the need for harsh cleaning agents and disinfectants needed to deal with intractable microbes in public facilities. This gradually reduces the environmental impact of the use of these cleaning agents in buildings, especially medical facilities.

3- Cost-effective

Antimicrobial coatings help reduce maintenance costs. When the paint is placed on a surface, it prevents staining, discoloration, absorption, or other factors affecting the appearance of the object. It provides the additional financial burden and labor that could have been required to maintain or replace these things.

4- Increasing age

Microbial protection combined with the maintenance provided by antimicrobial coatings increases the shelf life of objects, as they are protected from discoloration, odor and other damage caused by microbial activity.

5. The value of infrastructure

The application of antimicrobial coatings not only protects surfaces, but also contributes to the standard of the infrastructure as a whole. The presence of these coatings enables organizations to provide a safer and cleaner environment for the people in them. The use of these coatings on surfaces carries a deeper message that organizations care about the safety and atmosphere they provide to people. It certainly adds to the value of the building and public infrastructure.

3.2 Risks of antimicrobial coatings:

While there are tremendous benefits to antimicrobial paint, there are some drawbacks. The various risks associated with using antimicrobial coatings on surfaces include:

• Antimicrobial coatings can emit active ingredients that may slowly enter the ecosystem, causing long-term health risks.

• Active ingredients released from coatings containing silver, zinc, and copper can have toxic effects on fish, crustaceans, algae, etc. These toxic ingredients consumed by fish are ultimately consumed by humans.

• Similarly, the use of antimicrobial coatings on fabrics to prevent microbial growth can lead to the introduction of toxins into wastewater, ultimately damaging the marine environment.

• Active nanocomponents that are submerged and emit slowly may lead to different or new adaptive microbes such as drug-resistant bacteria.

• Most of the above cases are caused by antimicrobial coatings that filter ingredients to kill microbes. Flora Coatings has developed a biomicrobial coating called Invesil that does not leak into ingredients and is considered safe.

3.3 Safe use

The Scientific Committee on Emerging and Newly Determined Health Risks (SCENIHR) insists on “wise use of antimicrobials.” As a result, there was a universal need to design safe antimicrobial coatings. It has led to the Safe-by-Design concept, which emphasizes the need to design a product that eliminates hazardous materials. Highlights the release control of antimicrobial elements from paint. It can also be designed to target certain specific microbes without harming other bacteria. Moreover, there is a need to use an appropriate production process that takes care of all safety

requirements. A study of hospital wastewater treatment has been proposed to prevent it from affecting marine life.

New technologies have evolved with many researches in the field.

Polymers, safe, antibacterial surfaces and other innovative technologies have been used to neutralize the harmful effects of antimicrobial coatings. Products are now designed with safety, convenience and cost-effectiveness as a priority.

Today, the technology is widely used in the field of medicine with appropriate safety standards and extreme care. In the case of medical implants in the body, there is a high chance of developing a bacterial infection. Also, implants are difficult to remove and replace frequently. So before they are placed in the human body, medicinal implants are treated with non-toxic, biostable and biocompatible antibacterial agents.

3.4 Antimicrobial coatings market:

According to the Grand View Research Report, in 2015, the global market for antimicrobial paint was estimated at $2.44 billion. The 2019 report notes that the market is expected to grow at a CAGR of 11.5 percent between 2019 and 2024. In 2019, the antimicrobial paint market generated US$2.8 billion, and by 2024, it is expected to

reach US$5.4 billion. The market for antimicrobial coatings is expected to increase significantly due to the current COVID-19 pandemic crisis. Demand for antimicrobial coatings includes silver, copper and other antimicrobial coatings.

The main application areas are:

- Medical

- Indoor air quality systems

- Mold treatment

- Textiles

- Food and drinks

- Building and construction

Governments around the world are concerned about HCAIs. So there is an increase in demand for antimicrobial coatings, which play a vital role in preventing the spread of infection. The market is experiencing steady growth in North America and Europe, as governments are taking important steps in creating awareness about the usefulness of these coatings. North America is the largest market due to the high medical and living standards in the United States. The government has imposed strict rules for dealing with HCAIs in North America and Europe. The demand for antimicrobial silver coatings is increasing in North America. Some of the best manufacturers on the antimicrobial coatings market are:

- Axalta coating systems

- BASF

- Akzo Nobile

- RPM International

- PPG Industries

- Sheron Williams

3.5 The future of antimicrobial coatings:

The antimicrobial paint sector is full of activity. Research and innovation continue to provide better, safer, more innovative and affordable antimicrobial coatings. The reason behind the research is the steady growth in demand in North American countries and Europe. There has also been an increase in demand in the Asia-Pacific, Africa, Latin America and the Middle East regions as well.

Moreover, there is an urgent need for a controlled editing approach. All of these factors lead to a sharp increase in demand coupled with innovation. Future antimicrobial coatings should perform all functions through integration. Also, the need for antimicrobial coatings will spread to more and more public buildings. The future may see antimicrobial coating in almost all buildings as an easy way to keep germs away as well as maintain a healthy environment.

3.6 Moisture resistant paints:

Moisture-proof paint

• Helps prevent the accumulation of bacteria and mold on walls, walls, kitchens, bathrooms and home furniture, prevents the presence of an unpleasant smell inside the house and protects rooftops from moisture and water leakage, through high steam penetration in order to allow the formation of a flexible layer that dries steam and water at high speed.

• In addition to applying moisture-proof paint to concrete, wallpaper, wood and plaster, filling cracks and resisting dirt on walls, windows and other places that lead to the accumulation of bacteria, including these paints:

3.7 Moisture-proof acrylic paint

• Acrylic paint is one of the paints used in wall paper paint that fills gaps and cracks in the wall and helps get rid of moisture and bacteria.

• There may be many types of acrylic paints and a paint (acrylic resin) is characterized by flexibility, strength and rigidity in resisting ultraviolet rays and high humidity temperatures and protects against corrosion.

• While the paint (phenylacetate) is made of acrylic paints, which is characterized by the fact that it is without an unpleasant smell after painting and is characterized by the ease of adhesion to surfaces, which prevents the presence of spaces between the paint of the walls and the cause of accumulation of bacteria and moisture.

• Acrylic paint also provides breathing and moisture disposal inside the house and isolates moisture to reduce the risks it causes in the walls and walls of the house.

3.8 Moisture-proof latex paint

Latex paint is a wall paper paint derived from natural materials that disperses water to attach the particles of the material to obtain the highest degree of adhesion to surfaces and ceilings when painting to insulate moisture.

• Latex paint is also resistant to moisture and dirt and is protected from corrosion and does not lead to an accumulation of dust and environmental factors in the house.

• Latex is also a moisture-proof paint that expels dust from the house and allows the presence of air and breathing, which helps individuals and the family to ventilate and helps those suffering from allergies because oxygen bubbles do not form on surfaces.

• It is also characterized by rapid drought, especially in emergency conditions or even in winter paint. It is also easy to clean and remove dirt and dust quickly.

• In addition to latex paint is one of the paints used in painting walls, ceilings and floors for houses and buildings. Paint also uses the facades of office desks or offices of companies and factories.

3.9 Moisture-proof silicone paint

• Silicone paints such as previous acrylic and latex paints are moisture-resistant paints that distract water from its presence on walls and ceilings.

• Silicone paint is also characterized by good adhesion to surfaces, walls, ceilings and concrete to insulate moisture.

• It also hides cracks and roughness on walls and ceilings.

• In addition to making shade in the walls through paint colors.

• Paint tolerates direct sunlight such as temperature changes.

• It is also resistant to dust, dust, fungi and bacteria.

In order to protect the roofs, ceilings and walls of the house from moisture and get rid of the accumulation of bacteria and fungi, we must do moisture-resistant paint to fill cracks and penetrate dust and dust and reduce the risks that lead to real problems due to moisture.

CHAPTER FOUR

4.1 Samples used in laboratory test :

Some types of dyes available in the market were taken for laboratory testing to determine the type of bacterial growth formed inside them. It became clear after laboratory examination and the quality of many types of bacterial growth because these dyes are highly susceptible to biological growth processes (bacterial and fungal growth).

The reason is because they are dyes that do not contain any principles to resist the different biological growth on their surface, and therefore their effects, which are significant on the health and economic side, and their effects on the exterior decoration of buildings and surfaces. In these pictures below , show the biodeterioration of bacteria in paints .

4.2 Bacterial growth and diagnosis

These types of bacteria were diagnosed after a careful laboratory examination of dyes, and the presence of these types of microbes was found ***(bacteria E.coli , Klebsiella spp and Staphylococcus spp)*** .

4.2.1 bacteria E.coli and effects on human health

Escherichia coli (E. coli) bacteria normally live in the intestines of healthy people and animals. Most types of E. coli are harmless or cause relatively brief diarrhea. But a few strains, such as E. coli O157:H7, can cause severe stomach cramps, bloody diarrhea and vomiting.

You may be exposed to E. coli from biodeterioration in dyes — Healthy adults usually recover from infection with ***E. coli O157:H7*** within a week. Young children and older adults have a greater risk of developing a life-threatening form of kidney failure.

Symptoms:

Signs and symptoms of E. coli O157:H7 infection usually begin three or four days after exposure to the bacteria. But you may become ill as soon as one day after exposure to more than a week later. Signs and symptoms include:

- Diarrhea, which may range from mild and watery to severe and bloody
- Stomach cramping, pain or tenderness
- Nausea and vomiting, in some people

4.2.2 Klebsiella

is a type of Gram-negative bacteria that can cause different types of healthcare-associated infections, including pneumonia, bloodstream infections, wound or surgical site infections, and meningitis. Increasingly, Klebsiella bacteria have developed antimicrobial resistance, most recently to the class of antibiotics known as carbapenems. Klebsiella bacteria are normally found in the human intestines (where they do not cause disease). They are also found in human stool (feces). In healthcare settings, Klebsiella infections commonly occur among sick patients who are receiving treatment for other conditions. Patients whose care requires devices like ventilators (breathing machines) or intravenous (vein) catheters, and patients who are taking long courses of certain antibiotics are most at risk for Klebsiella infections. Healthy people usually do not get Klebsiella infections.

spread of klebsiella

To get a Klebsiella infection, a person must be exposed to the bacteria. For example, Klebsiella must enter the respiratory (breathing) tract to cause pneumoniae, and that will done when the the biodeterionation occur in dyes

In healthcare settings, Klebsiella bacteria can be spread through person-to-person contact (for example, from patient to patient via the

contaminated hands of healthcare personnel, or other persons) or, less commonly, by contamination of the environment. The bacteria are not spread through the air.

Patients in healthcare settings also may be exposed to Klebsiella when they are on ventilators (breathing machines), or have intravenous (vein) catheters or wounds (caused by injury or surgery). Unfortunately, these medical tools and conditions may allow Klebsiella to enter the body and cause infection.

4.2.3 Staphylococcus spp

S. aureus has long been recognized as one of the most important bacteria that cause disease in humans. It is the leading cause of skin and soft tissue infections such as abscesses (boils), furuncles, and cellulitis. Although most staph infections are not serious, S. aureus can cause serious infections such as bloodstream infections, pneumonia, or bone and joint infections.

Staphylococcus can transmission from the dyes that have bio deterionation allow the bactereia to grow on its surface and then these surfaces become the source of Staphylococcus and inflow or trans to the upper skin layer in human body .

4.3 The conclusion

The rapid growth of the antimicrobial paint market in terms of demand, as well as the call for improvement, paves the way for a new market scenario in the future. The industry is growing from multiple directions. On the one hand, there is a sharp increase in global demand, due to increased awareness of the advantages of these coatings, while on the other hand, market forces are pressing for more research in this area, leading to better products in safety and cost conditions. Also, new materials are being explored as well as new areas. It looks like the antimicrobial paint sector will soon witness a historic revolution.

4.4 Recommendation

- As a result of the continuous acceleration, the demand for dyes increases, so other recent studies must be continued

- Paying attention to the quality of biological pollutants and bacterial colonies that can grow inside the dyes

- Continuous research and development in the field of microbial contamination of dyes in the future

- External buildings that are more susceptible to environmental factors must be painted with paints that are resistant to environmental factors and bacterial contamination.

- Focus future studies on the possibility of developing current dyes to reach a better result

- Maintaining the effectiveness of dyes against microbes and at the same time reducing the danger of these dyes to the environment, human and animal health, and the hope that they are available in the market locally at low cost prices.

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